CHAPTER 15

RELINING EXISTING PIPE STRUCTURES

A new method of reconditioning existing structures is currently being used on some contracts. The method involves relining an existing structure with a polyethylene liner approximately the same diameter as the inside diameter of the existing pipe. Using this method can save costly disruption to traffic, especially in areas where a structure has a high fill over it.

A sample of the special provisions for such a repair is shown in the appendix. These provisions are set up for a particular contract and provisions may change for future contract provisions.

SLIP LINING OF ROADWAY CULVERTS WITH POLYETHYLENE CULVERT PIPE

LINER

DESCRIPTION. This specification covers the requirements for high density polyethylene pipe liner for relining existing in-place concrete, vitrified clay, or metal culvert pipe and filling the annular space between the liner and the existing culvert with cellular grout. The Contractor shall furnish and install the liner and grout in accordance with 105.03.

MATERIALS

MATERIALS. The materials used to manufacture the liner shall be high density high molecular weight polyethylene pipe material meeting the requirements of Type III, Class C, Category 5, Grade P34 as defined in ASTM D 1248. Clean rework material generated by the Manufacturers own production may be used so long as the liner produced meets all the requirements of the specification.

The liner material shall be homogeneous throughout. The liner shall be free from visible cracks, holes, foreign inclusions, or other injurious defects. The liner shall be uniform as commercially practical in color, capacity, density, and other physical properties.

The average nominal inside diameter of the liner shall be true to the specified liner size V 1/4 in. Standard laying lengths shall be a minimum of 19 ft, but not exceed 40 ft or as specified by the Engineer.

The liner shall have a maximum n-factor of .012 and shall be capable of maintaining a minimum flow rate equivalent to 100 percent of the original in-place culvert. The liner shall have a Standard Dimension Ratio, SDR, equal to 32.5, or have a minimum pipe stiffness of 46 psi when tested per ASTM D 2412 or be Class 160 type pipe in accordance with ASTM F 894. SDR is defined as the ratio of the liner outside diameter to the minimum thickness of the wall of the liner. SDR can be expressed mathematically as:

$$SDR = \frac{D}{T}$$

Where D = liner outside diameter in mm (in.)
t = minimum liner wall thickness in mm (in.)

Jointing the liner shall be by either bell and spigot, screw type, thermal welding, or a grooved press-on joint approved by the Engineer. The joint shall have sufficient mechanical strength to allow the liner to be installed through the existing pipe without affecting the joint's integrity. Jointing must provide water tight integrity for all joints. Jointing of the liner shall not interrupt the flow characteristics of the pipe.

A 300 mm (12 in.) section of the liner shall show no evidence of splitting, cracking, or breaking when compressed between parallel plates to 40 percent of its outside diameter within 2 to 5 minutes. The liner shall have sufficient rigidity to withstand being placed by either pulling or pushing and shall exhibit a minimum amount of distortion.

The manufacturer shall furnish certifications to the Division of Materials and Tests stating that the material used in the manufacture of the liner meets the requirements of ASTM D 1248 for the type, class, category, and grade specified. The manufacturer shall also certify that the finished liner is in compliance with this specification.

The materials used to manufacture the cellular grout shall be in accordance with the following.

Fine Aggregate	904.01
Fly Ash	901.02
Foam Concentrate	ASTM C 796
Water	913.01

Admixtures, retarders, and plasticizers used shall be in accordance with the foam concentrate suppliers specifications. Portland Cement shall be in accordance with 901.01@b) except type II cement shall not be used.

The grout shall be made using the preformed foam process using foam generating equipment calibrated by the foam manufacturer to produce a precise and predictable volume of foam. The foam concentrate shall be certified by the manufacturer to have specific liquid/foam expansion ratio at a constant dilution ratio with water.

The specific job mix shall be submitted by the foam concentrate supplier certified grouting contractor to the

Engineer for approval prior to use on the project. The mix shall have a minimum 28 day compressive strength of 150 psi. The mix shall be tested and verified in accordance with these specifications or shall be approved based on prior acceptance and suitable performance an Department projects.

Grout mixed off site shall be delivered to the job site in a truck mixer in accordance with 702.09 filled to half its capacity. The foam concentrate shall then be added to the cement mix in the truck and mixed to a uniform consistency.

Grout mixed on site shall be hatched in a deck mate or a similar device. Small batches of approximately 1 cubic yard shall be mixed and pumped in a continuous operation.

For each day worked or for each 100 cubic yards placed, four test cylinders measuring 3 in. by 6 in. shall be cast. The cylinders shall be prepared, cured, and transported in accordance with ASTM C 31 and ASTM C 192. The cylinders shall be tested in accordance with ASTM C 39 except the test specimens shall be broken within the permissible tolerance prescribed as follows:

Test Age	Permissible Tolerance
24 h	1/2 h
3 days	1 h
7 days	3 h
28 days	22 h

The cylinders shall be obtained from the point of placement.

EQUIPMENT. All equipment necessary for the satisfactory performance of this work shall be approved by the Engineer. This equipment shall include all machinery necessary for the installation of the liner, grout and the reworking of the temporary easements.

The equipment used to produce the grout, and all equipment used in the mixing, pumping, and placing shall be certified as to its suitability by the supplier of the foam concentrate.

The Contractor supplying and placing the grout shall be certified by the foam concentrate supplier and shall be capable of developing a mix design, batching, handling, pumping and placing grout under the project conditions.

RIGHT OF ENTRIES. All right of entries required for the work shall be acquired by the Contractor. All damage within these areas shall be repaired to original condition by the Contractor. Bare areas or areas having sod cover shall be seeded and mulched. All damaged fences shall be repaired by the Contractor. The Contractor shall install and maintain temporary fence as directed by the Engineer.

CONSTRUCTION REQUIREMENTS

CONSTRUCTION REQUIREMENTS. The Contractor shall re-establish the flowline of any eroded inverts, as directed by the Engineer, with grout meeting the requirements as set out in the Standard Specifications. Pre-mixed grout may be used subject to approval of the Engineer. The Contractor shall maintain a positive flowline in the liner. Any obvious cavities =der the existing pipe shall be filled with grout.

After the liner has been completely inserted and has been inspected by the Engineer, it shall be cut off flush with the ends of the existing culvert or as directed by the Engineer. it shall then be grouted in place. If the liner has been exposed to the sun before the insertion is made, it shall be allowed to cool to the temperature of the existing culvert before it is cut off and grouted.

Block and mortar bulkheads shall be placed at both ends of the culvert. A 50 mm (2 in.) vent hole at the crown and a 25 mm (I in.) hole at the invert shall be placed in the downstream bulkhead. An access hole sized to facilitate the method of grout input and a 50 mm (2 in.) air vent shall be placed at the crown in the upstream bulkhead.

The grout shall be placed from the upstream end of the culvert where practical. The vent holes in the downstream bulkhead shall be plugged as soon as grout begins to flow out each hole. The 50 mm (2 in.) air vent in the upstream bulkhead shall be kept clear until grout begins to flow out of it. It shall then be plugged.

The grout shall be placed by either gravity flow or by low pressure pumping so as to completely fill all voids within the annular space without causing deformation of the liner. The grout shall extend for the full length of the culvert.

Grout placed by gravity flow shall be limited to a maximum length of flow of ten feet for each foot of available head per access hole. Additional access holes, where required, shall be drilled from the top and sleeved with 6 in. pvc piping.

Grout placed by low pressure pumping shall be done such that the maximum pressure developed in the cavity shall not exceed the liner Manufacturers recommendation for external pressure allowed. Additional access holes, where required, shall have a minimum diameter of 4 in. and shall be drilled from the top and sleeved with pvc piping.

Liner storage areas shall be approved by the Engineer. All drainage structures and ditches shall remain open at all times. All traffic control shall be in accordance with the MUTCD or as directed.

All liner sizes will be approved by the Engineer prior to installation.

All incidental work, such as brush removal, flowline adjustments, etc., shall be accomplished by the Contractor. Where required, and practical, a bull nose device shall be pulled through the existing culvert to facilitate the liner installation. The bull nose device shall be of appropriate diameter to permit the installation of the intended liner size. The pipe shall be completely cleared of all foreign material just prior to the installation of the liner.

METHOD OF MEASUREMENT. Polyethylene culvert pipe liner will be measured in accordance with 715.11. Grout will not be measured.

BASIS OF PAYMENT. The accepted quantities of pipe, polyethylene liner will be paid for at the contract unit price per linear foot for the size specified complete in place.

The cost of grout; flowline adjustments; brush removal; the grouting of cavities or the flowline of the existing pipe; the maintenance of traffic; of acquiring easements; the repair of damage to easements or fences including seeding and mulching; the furnishing, erection, and removal of temporary fence; and all other incidental work will be not be paid for separately but shall be included in the cost of pay item.

JACKED PIPE

This work shall consist of jacking steel or reinforced concrete pipe through or under an embankment in accordance with these specifications and in reasonably close conformance with the lines and grades shown on the plans or as directed.

Materials shall be in accordance with the following:

	Concrete
Reinforced Pipe	907.02
Steel Pipe	908.11

CONSTRUCTION REQUIREMENTS

An approach trench shall be dug at the forward end of the proposed pipe to a depth sufficient to form a vertical face at least 1 ft higher than the top of the pipe and large enough to provide ample working room. The size and height of this vertical face may be varied, but the roadbed and shoulders shall always be adequately protected. After the pipe is installed, the excavated area not -occupied by the pipe shall be backfilled Unsuitable material and thoroughly compacted into place.

Sheeting and bracing shall be provided if the nature and conditions of the soil or height of exposed faces is such as to endanger either the traveling public or the integrity of the road surfacing.

When the use of explosives is necessary for the prosecution of the work, their use shall be in accordance with 107.11.

When ground water is known or anticipated, a dewatering system of sufficient capacity to handle the flow shall be maintained at the site until its operation can be safely halted. The dewatering system shall be equipped with screens or filter media sufficient to prevent the displacement of fines.

Jacked pipe shall be so constructed as to prevent leakage of any substance from the pipe throughout its length. Installation by open-trench methods will be permitted only at locations indicated and shall be in accordance with the applicable specifications for that type of installation. Jacked pipe shall be installed by the following methods.

JACKING

This method shall consist of pushing steel or reinforced concrete pipe into the embankment. All pipe shall be handled, unloaded, and stacked so as to prevent any damage to the joints of the pipe.

Excavation shall be undertaken within a steel cutting edge or shield attached to the front section of pipe to form and to cut the required opening for the pipe. Excavation shall be undertaken with the shield and shall not be carried ahead of the pipe far enough to cause loss of soil. When jacking in loose, granular, or running soils, the shield shall have means for inserting steel baffle plates and shelves for the purpose of preventing voids.

The Contractor's superintendent or engineer experienced in pipe jacking techniques, shall be present at all times while work is proceeding and shall be responsible for checking the line and grade.

The thrust wall shall be adequate for installation of the jacked pipe. It shall be constructed normal to the proposed line of thrust.

A suitable lubricant, such as bentonite, may be applied to the outside surface of the jacked pipe to reduce frictional forces. This shall be accomplished by the use of pressure equipment which pumps the lubricant to the outside of the shield on the lead pipe or the lubricant may be pumped to the outside surfaces of the pipe through grout holes.

Jacking equipment which is designed to provide the forces necessary for installation of the pipe shall be used. The thrust load shall be imparted to the pipe through a suitable thrust ring which shall be sufficiently rigid to ensure distribution of the load without creating point loading.

When necessary to prevent loss of soil at the heading, the face of the excavation shall be adequately bulkheaded when work is shut down at the end of the working day.

Bracing and backdrops shall be so designed and jacks of sufficient rating used so that jacking ran be progressed without stoppage, except for adding lengths of pipe, until the leading edge of the pipe is at least 15 ft. beyond the inside edge of the pavement as shown on the plans.

Boring

This method shall consist of pushing the pipe into the fill with a boring auger rotating within the pipe to remove the spoil. Advancement of the cutting head ahead of the pipe will not be permitted except for that distance to permit the cutting head teeth to cut clearance for the pipe. If granular, loose, or unstable soil is encountered during the boring operation, the cutting head shall be retracted into the casing a distance that permits a balance between pushing pressure and the ratio of pipe advancement to quality of spoil to ensure no voiding is taking place. The excavation by the cutting head shall not exceed the outside diameter of the pipe by more than 1/2 in.. The face of the cutting head shall be arranged to provide reasonable obstruction to the free flow of soft or porous material.

The use of water or liquids to soften or wash the face will not be permitted. Water may be used in sticky clays to facilitate spoil removal providing water is introduced behind the cutting head. Lubricating agents, such as bentonite, may be used to lubricate the casing and reduce friction between casing and embankment.

Plans and descriptions of the arrangement to be used shall be submitted for approval. No work shall proceed until such approval is obtained.

If an obstruction is encountered during installation which stops the forward progress of the pipe, and it becomes evident that it is impossible to advance the pipe, and if ordered, operations shall cease and the pipe shall be abandoned in place and filled completely with grout, or other approved materials. The abandoned work will be paid for at 75% of the contract unit price as specified in the schedule of pay items.

Bored or jacked installations shall have a bored hole essentially the same as the outside diameter of the pipe. If voids should develop or if the bored hole diameter is greater than the outside diameter of the pipe by more than approximately one inch, grouting or other approved methods shall be employed to fill such voids with no additional payment.

Jacking Steel Pipe Pipe joints shall be welded in accordance with 711.32. Pipe joints shall be water tight. Minimum wall thickness of the pipe shall be as follows:

OUTSIDE DIAMETER, (inches)	WALL THICKNESS (inches)	
	Casing Contains Carrier	Casing Used as Carrier
18 or less	1/4	1/4
19-20	1/4	5/16
21-26	1/4	3/8
27-30	3/8	1/2
31-42	3/8	1/2
43-48	1/2	9/16

Only reinforced concrete pipe of 30 in. inside diameter and larger may be jacked, and shall be class IV or stronger with tongue and groove joints. AD pipes shall have steel reinforcement concentric with the pipe wall, and where required, additional reinforcement at the ends of the pipe. The pipe shall be in accordance with ASTM C 76M (C 76).

To avoid concentrated loads at the joints from pipe to pipe, strips of plywood, asphalt roofing paper, or other similar resilient materials shall be inserted around the circumference in the joints as each pipe is placed ahead of the thrust ring. Resilient material must also be used between the pipe end and the thrust ring.

Method of Measurement. Jacked pipe will be measured by the linear foot, complete in place. Headwalls, culvert pipe end sections, reinforcing steel, and anchors will be measured in accordance with 715.11.

Basis of Payment. The accepted quantities of jacked pipe will be paid for at the contract unit price per foot for pipe, jacked, of the type and size specified, complete in place.

Headwalls, culvert pipe end sections, reinforcing steel, and anchors will be paid for in accordance with 715.12.

Payment will be made under:

Pay Item	**Unit**
Pipe, Jacked, Circular, _____ (material), _____ (diameter) in	LFT

The costs of excavation, backfilling, boring, welding, disposal, and necessary incidentals shall be included in the cost of the pay item.